Sains Malaysiana 54(7)(2025): 1797-1811
http://doi.org/10.17576/jsm-2025-5407-13

Evaluation of Aesthetic and Mechanical Properties of Single Shade Dental Polymer Resin: An *in vitro* Study

(Penilaian Sifat Estetik dan Mekanikal Resin Polimer Pergigian Satu Warna: Suatu Kajian *in vitro*)

LIM CHIEN WEN[1], KELKAR KASTURI CHANDRASHEKHAR[1], NOOR AZLIN YAHYA[2] & HADIJAH ABDULLAH[1,*]

[1]*Restorative Dentistry Department, Faculty of Dentistry, MAHSA University, Selangor, Malaysia*
[2]*Restorative Dentistry Department, Faculty of Dentistry, Universiti Malaya, 50603 Kuala Lumpur, Malaysia*

Received: 29 August 2024/Accepted: 21 May 2025

ABSTRACT

This study evaluated the aesthetic and mechanical properties of single shade resin composite comparing with three different resin composites. Colour matching was performed on ninety class III preparations on acrylic central incisors with shades B1, B2, and A3. One single shade (Omnichroma) and three different multishade resin composite (Filtek Universal Restorative; Palfique LX5; Beautifil II) were used for restoration on each side. Digital photograph was taken under standardized set-up. Colour measurements were taken in the centre of restoration, and tooth surface 1.0 mm from the tooth/restoration margin. The colour difference was analysed using CIELAB equation. For colour stability and surface roughness evaluation, resin composites (10 × 2 mm) were prepared and polished with Sof-Lex™ discs. Baseline colour and surface roughness were assessed using digital spectrophotometer and 3D Optical Surface Texture Analyzer, respectively. After 28 days of immersion in distilled water or coffee, post soaking colour changes and surface roughness were recorded. Flexural strength test was performed on 40 specimens (25 × 2 × 2 mm) according to ISO 4049. Three point bending test was performed using the universal testing machine. Omnichroma showed higher colour difference compared to composites in B1 shade ($p<0.05$). After 28 days of coffee immersion, Omnichroma had significantly different colour stability compared to multi-shade system ($p<0.05$). There was no difference between the surface roughness of Omnichroma with multi-shade system. Omichroma exhibited the highest flexural strength statically. Further strengthening is needed to enhance Omnichroma's properties for clinical use while preserving its ability to match surrounding tooth structure.

Keywords: Colour matching; colour stability; flexural strength; resin composite; surface roughness

ABSTRAK

Penyelidikan ini menilai sifat estetik dan mekanikal resin komposit satu warna berbanding dengan tiga resin komposit yang berbeza. Pemadanan warna dilakukan pada sembilan puluh persediaan Kelas III pada gigi insisiv tiruan dengan warna B1, B2 dan A3. Satu resin komposit satu warna (Omnichroma) dan tiga resin komposit pelbagai warna (Filtek Universal Restorative, Palfique LX5 dan Beautifil II) digunakan untuk pemulihan pada setiap sisi. Gambar digital diambil di bawah tetapan piawai. Ukuran warna diambil di pusat pemulihan dan pada permukaan gigi 1.0 mm daripada margin gigi/pemulihan. Perbezaan warna dianalisis menggunakan persamaan CIELAB. Untuk penilaian kestabilan warna dan kekasaran permukaan, resin komposit (10 × 2 mm) disediakan dan digilap dengan cakera Sof-LexTM. Warna asas dan kekasaran permukaan dinilai masing-masing menggunakan spektrofotometer digital dan Penganalisis Tekstur Permukaan Optik 3D. Selepas 28 hari perendaman dalam air suling atau kopi, perubahan warna selepas perendaman dan kekasaran permukaan direkodkan. Ujian kekuatan lenturan dilakukan pada 40 spesimen (25 × 2 × 2 mm) mengikut ISO 4049. Ujian lenturan tiga titik dilakukan menggunakan mesin ujian universal. Omnichroma menunjukkan perbezaan warna yang lebih tinggi berbanding komposit pada warna B1 ($p<0.05$). Selepas 28 hari perendaman dalam kopi, Omnichroma mempunyai kestabilan warna yang berbeza dengan ketara berbanding sistem pelbagai warna ($p<0.05$). Tiada perbezaan antara kekasaran permukaan Omnichroma dan sistem pelbagai warna. Omnichroma menunjukkan kekuatan lenturan tertinggi secara statistik. Pengukuhan lanjut diperlukan untuk meningkatkan sifat Omnichroma bagi kegunaan klinikal sambil mengekalkan keupayaannya untuk menyesuaikan struktur gigi sekeliling.

Kata kunci: Kekasaran permukaan; kekuatan lenturan; kestabilan warna; komposit resin; padanan warna

INTRODUCTION

Restoring anterior teeth represent a complex challenge for the clinicians. These challenges arise from attempting to attain true harmonization of the primary parameters in aesthetics such as colour, texture and shape (Terry & Leinfelder 2004). Primarily, to match the tooth colour with its desirable restorative material is a struggle for many dentists. A resin composite produces a colour match called as the 'chameleon effect' as it absorbs light from the neighbouring tooth structures. The resin composite's capacity to match the surrounding tooth structure in terms of colour is influenced by the refractive index of the fillers and polymer matrix (Oivanen et al. 2021). However, the colour matching ability of a resin composite is also influenced by the restoration size. Better colour matching will be achieved with smaller restoration size and increase restorative material translucency (Saegusa et al. 2021).

A good desired colour matching of resin composite with the tooth structure is not only crucial in the beginning of treatment but also for a longer period of time. Although resin composite shows promising results in the field of aesthetic dentistry, however, one of the drawbacks of resin composite is its discolouration in the long term, and poor colour stability (Menon, Ganapathy & Mallikarjuna 2019). Hence, different beverage had influenced the colour stability of resin composite and caused discolouration over a period of time.

One of the major causes of extrinsic discolouration of resin composite are due to surface roughness. Chances of discolouration of composite are higher when the rough surface are greater than 0.2 μm due to higher chances of biofilm accumulation (Bollenl, Lambrechts & Quirynen 1997). The reason of more biofilm formation is due to the fact that a rough surface on the restoration can act as a buffer against shear force and also increase the area available for biofilm formation (Quirynen & Bollen 1995).

Recent advancements in dental resin composites have focused on enhancing both aesthetic and mechanical properties to meet the evolving demands of restorative dentistry. Studies from Ren et al. (2024), have introduced novel formulations and comparative analyses to optimize these materials. In this study, a novel 'dense' microhybrid filler system was introduced with 85 wt% filler loading. They studied on a self-developed resin composites (SRCs), particularly SRC3, which demonstrated excellent mechanical performance, including high flexural and diametral tensile strength, comparable to the commercial Z350 XT composite, offering a balanced combination of physicochemical properties and wear resistance.

Besides that, emerging trends for future resin-based materials are Bisphenol A free alternatives, such as fluorinated urethane dimethacrylate (FUDMA)-based composites have shown comparable mechanical properties to traditional Bis-GMA-based composites, with reduced water sorption and antibacterial properties, offering a safer option for patients (Mahmoudi Meimand et al. 2024). Secondly, the incorporation of silica nanoparticles and TRIS (tris(hydroxymethyl)aminomethane) into resin formulations has shown the enhancement of shear modulus and flexural strength, indicating improved structural integrity and resistance.

Even though modern resin composites have sufficient mechanical qualities to be applied to both the anterior and posterior surfaces of teeth, there are some concerns regarding fracture and wear of the restoration still exists when the materials are placed in high stress areas, particularly in patients with parafunctional habits or bruxism (Moraes et al. 2022). To improve the mechanical properties, nanoparticles have been used as dental composite fillers. Fillers with smaller particle sizes can enhance flexural strength due to their increased surface area, leading to high surface energy at the filler-matrix interface (Kundie et al. 2018).

In 2019, a resin composite material called Omnichroma was introduced by Tokuyama Dental that takes on the shade of the surrounding tooth structure (Sharma & Samant 2021). A distinctive feature of Omnichroma composite is based on 'smart chromatic technology'. It has the ability to capture the structural colour of its surrounding tooth structure by controlling the size of the fillers (260 nm spherical). No added pigments or dyes are present, the fillers themselves produce red-to-yellow structural colour as ambient light passes through the composite which able to blend with the colour of the surrounding tooth (Chu, Trushkowsky & Paravina 2010).

Omnichroma has demonstrated excellent visual colour matching in several studies, with some research showing performance comparable to traditional multi-shade systems such as Filtek Universal Restorative (3M ESPE). Despite its effective visual blending capabilities, Omnichroma exhibited higher ΔE values than Filtek Universal Restorative shades A3.5 and B2, indicating less accuracy in instrumental colour matching- though still within acceptable visual thresholds (Bisharah et al. 2022).

In terms of colour stability, both Omnichroma and Filtek Universal Restorative, 3M ESPE showed significant discoloration after artificial aging procedures such as thermocycling and immersion in staining solutions like tea and red wine. These changes, often exceeding the clinically acceptable ΔE thresholds, suggest that colour stability remains a limitation for both materials, though more pronounced in Omnichroma (Hassan, El-Damanhoury & El-Badrawy 2022).

Mechanically, Omnichroma provides flexural strengths and surface characteristics in the range of clinically acceptable values, though slightly lower than other universal composites (Mizutani et al. 2021). Studies indicate it achieves a good balance between volumetric wear and antagonistic enamel wear, highlighting its potential durability in occlusal restorations (El-Refai 2022).

To the best of our knowledge, there are scant studies done on this single shade composite. Therefore, more studies are required before Omnichroma can be used as alternative for conventional resin composite not only in aesthetic zone but also in stress bearing areas as Omnichroma has the potential to simplify the restorative process. The aim of this study was to evaluate the aesthetic and mechanical properties of a single shade dental resin composite (Omnichroma, Tokuyama Dental, Tokyo, Japan) compared to multi–shade resin composite (Filtek Universal Restorative, 3M ESPE, St. Paul, MN, USA), (Palfique LX5, Tokuyama Dental, Tokyo, Japan) and (Beautifil II, Shofu, Kyoto, Japan) resin composite. The null hypothesis of this study was that there is no difference between the colour matching, colour stability, surface roughness and flexural strength of single-shade resin composite with multi-shade system.

MATERIALS AND METHODS

A laboratory study was carried out. One single shade resin composite (Omnichroma, Tokuyama Dental, Tokyo, Japan) and three multi-shade resin composites (Filtek Universal Restorative, 3M ESPE, St. Paul, MN, USA; Palfique LX5, Tokuyama Dental, Tokyo, Japan and Beautifil II, Shofu, Kyoto, Japan) were evaluated in this study. The properties of these resin composite materials are presented in Table 1.

SAMPLE SIZE

The required sample size was determined using G Power software version 3.1.9.7, employing an a priori power analysis. The standard deviations used for the calculation were derived from a previous study by AlHamdan et al. (2021), which investigated the colour matching ability and colour stability of a single shade resin-based composite. Specifically, we extracted the standard deviation values for colour differences from the intervention group to ensure consistency in population characteristics.

For the present study, we aimed to detect a minimum effect size of d = 0.80 (large effect size) based on the difference observed between two comparison groups in the AlHamdan et al. (2021) study. The alpha error probability was set at 0.05, and the desired power (1 - β) was set at 0.80. The allocation ratio between groups was 1:1.

Based on these parameters, the minimum sample size calculated was 16 samples with 4 per group. After adding 15% of expected missing data, the total sample size is 18 samples. However, for this study, 90 samples were carefully chosen with 30 in each group to ensure more reliable results (AlHamdan et al. 2021). For colour stability, surface roughness and flexural strength test, the total sample size is 40 with 10 samples per group.

COLOUR MATCHING EVALUATION- PHOTOGRAPHIC ANALYSIS

Specimen preparation

Ninety (90) Class III preparations were performed on the mesial and distal surfaces of acrylic denture maxillary central incisors (Yamahachi, Japan) in three different Vita Classical shades (B1, B2, and A3) using an FG round diamond bur (head size: 2.7 mm) (Recodent, Taiwan) to fully penetrate and standardize the preparation. One single shade (Omnichroma) and three multishade universal resin composite (Filtek Universal Restorative; Palfique LX5 and Beautifil II) were used to build the restoration. The preparation was restored in a single layer increment and

TABLE 1. Properties of resin composite materials used in the study

Material	Manufacturer	Composition	Filler content % by weight/ volume	Shade
Ominichroma composite	Tokuyama Dental, Tokyo, Japan	UDMA, TEGDMA Uniform sized supra-nano spherical filler (260 nm spherical SiO_2- ZrO_2) Composite filler (include 260 nm spherical SiO_2- ZrO_2)	79/68	Single shade
Filtek Z350XT Universal Restorative composite	3M ESPE, St. Paul, MN, USA	Bis-GMA, UDMA, TEGDMA, bis-EMA Silica filler (20 nm), ZrO_2 filler (4-11 nm), clusters (0.6-20 μm)	78.5/63.3	B1, B2, A3
Palfique LX5	Tokuyama Dental, Tokyo, Japan	Bis-GMA, TEGDMA Silica-zirconia filler, composite filler, supra-nano-spherical filler (average size of 200 nm)	82/71	B1, B2, A3
Beautifil II resin composite	Shofu, Kyoto, Japan	Bis-GMA, TEGDMA Multifunctional glass filler and Surface Pre-Reacted Glass-ionomer filler based on fluoroboroaluminosilicate glass (size range 0.01-4.0 μm)	83.3/68.6	B1, B2, A3

Bis-EMA= Ethoxylated bisphenol-A-glycidyl methacrylate, Bis-GMA=Bisphenol-A glycidyl methacrylate, TEGDMA=Triethylene glycol dimethacrylate, UDMA=Diurethane dimethacrylate photo-cured for 20 s at light-curing distance of 2 mm on the labial surface with Woodpecker LED.B curing light (wavelength: 420-480 nm). All specimens were kept in a standard plastic tube and stored in an incubator set at 37 °C. The whole restorations were performed by a single operator.

COLOUR MATCHING TESTING

A digital camera (Canon EOS 700D, Canon) with a 90 mm lens (AF 90 mm F/2.8 1.1 Macro, Tamron) and a flash (MF12-DK1 Macro dual flash, Godox) were used to capture the digital photos (Figure 1). A cross-polarizing filter was placed on each side of the camera and a floor tripod was used to hold it steady in a standard 45-degree angle. Standardised parameters were used for all photos: exposure of 1/125 s, f(25), ISO400, manual flash configuration at 1/2 of its maximum power, distance of 45 cm, and 1:1 focusing in RAW format.

Two measurements were made of the restoration's colour: one towards the centre of the restoration, 1 mm from the tooth/restoration margin to the mesial or distal portion of the denture tooth, depending on whether the restoration was performed in that direction; and the other towards the tooth surface, immediately adjacent to the tooth/restoration interface, 1 mm from the margin, to reduce any potential surface alterations caused by reflected light (Figure 2). A software called Classic Colour Meter version 2.1.1 for Macbook, developed by Ricci Adams, was used to measure the CIELab values of all of the photos (Figure 3) (Pereira Sanchez, Powers & Paravina 2019).

The outcomes were L*, a*, and b*, respectively. These values indicate the colour's lightness (L* = 0 yields black, and L* = 100 indicates diffuse white; specular white may be higher), its position between red/magenta and green (a* indicates green, while positive values indicate magenta), and its position between yellow and blue (b* indicates blue, positive values indicate yellow). The following equation was used to compare the colour of the tooth surface and restoration during the colour difference analysis (ΔE):

$$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$$

COLOUR STABILITY EVALUATION

Specimen preparation

The specimens were prepared using the Omnichroma, Filtek Universal Restorative (B1 shade), Palfique LX5 (B1 shade), and Beautifil II (B1 shade) on a stainless-steel mould with perforations measuring 10 mm by 2 mm (Figure 4). A glass slide with a thickness of 1 mm was placed on top of a Mylar strip to ensure that the samples had a smooth surface.

After removing the glass slide, the specimen was light-cured from the top surface for 40 s using Woodpecker LED.B curing light (Guilin Woodpecker Medical Instrument Co, Guilin, China). The specimens were removed from the mould and the bottom surfaces were light-cured from the surface. Each specimen was polished using Sof-Lex™ (3M ESPE, St. Paul, MN, USA) polishing discs, starting from the coarsest to the finest discs for 10 strokes each using light pressure by one operator. Total of 40 disc-shaped specimens were prepared and 4 groups (n=10) were formed based on the restorative materials. Each group of specimen was placed in a standard plastic tube and stored in an incubator set at 37 °C for 24 h prior to the testing for baseline readings.

COLOUR STABILITY TESTING

The baseline reading of specimen was assessed using digital colour spectrophotometer (Konica Minolta Spectrophotometer CM-5, Germany) where each sample was placed on the illumination area (a circle of 3 mm diameter) and the reflectance values were measured after 1 s of being illuminated by a pulse xenon lamp. There was one reading per sample and the background was black in colour.

After recording the baseline reading, the specimens were divided into 4 groups based on the restorative materials and after that sub-grouped into 2 groups based on immersion mediums. Five grams of coffee (Nestle USA, Inc., Glendale, CA, USA) was poured into 250 mL of water at 100 °C to create the coffee solution. The powder was entirely dissolved after 10 min of vigorous stirring the coffee (Yannikakis et al. 1998). For distilled water, room-temperature distilled water was used. All of the beverages were replaced every three days, and the container was stirred every day for 28 days.

A 6 mL volume of each immersion solution was poured to the plastic container along with one specimen each and returned to the incubator (Figure 5). After 28 days, the specimens were washed under running water for 5 min and dried after removal from the stain solution. The colour change was assessed after 28 days of staining the specimens using digital colour spectrophotometer (Konica Minolta Spectrophotometer CM-5, Germany). The L*, a*, and b* measurements show the colour's lightness (L* = 0 yields black, and L* = 100 indicates diffuse white; specular white may be higher), as well as where the colour falls in relation to red/magenta and green (a* indicates green, while positive values indicate magenta), and blue (b* indicates blue, and positive values indicate yellow). L*, a*, and b* changes (Δ) were computed prior to and following stain solution immersion for the purpose of evaluating colour stability using CIELAB equation (Pereira Sanchez, Powers & Paravina 2019):

$$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$$

SURFACE ROUGHNESS EVALUATION

Surface roughness testing

The same specimens used for colour stability evaluation were used for surface roughness evaluation. The surface roughness of disc-shaped specimens (n=40) was measured

FIGURE 1. Set up for the photographic analysis

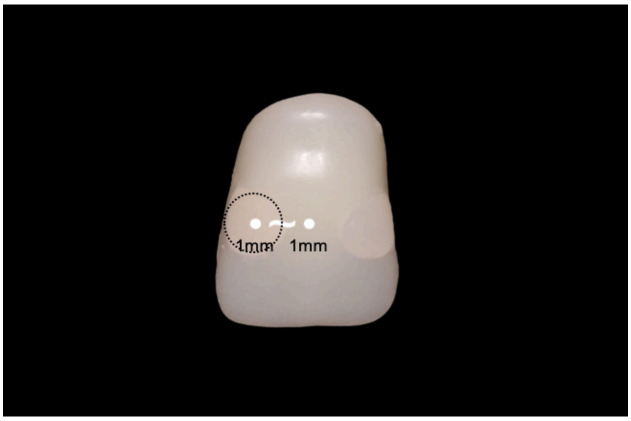


FIGURE 2. Representative image of colour acquisition. To evaluate colour matching, two colour measurements were performed: one toward the centre of the restoration, 1 mm away from the tooth/restoration margin; and another one toward the tooth surface, 1 mm away from the margin

FIGURE 3. CIELac colour coordinates (Classic Colour Meter version 2.1.1 for Macbook; Ricci Adams)

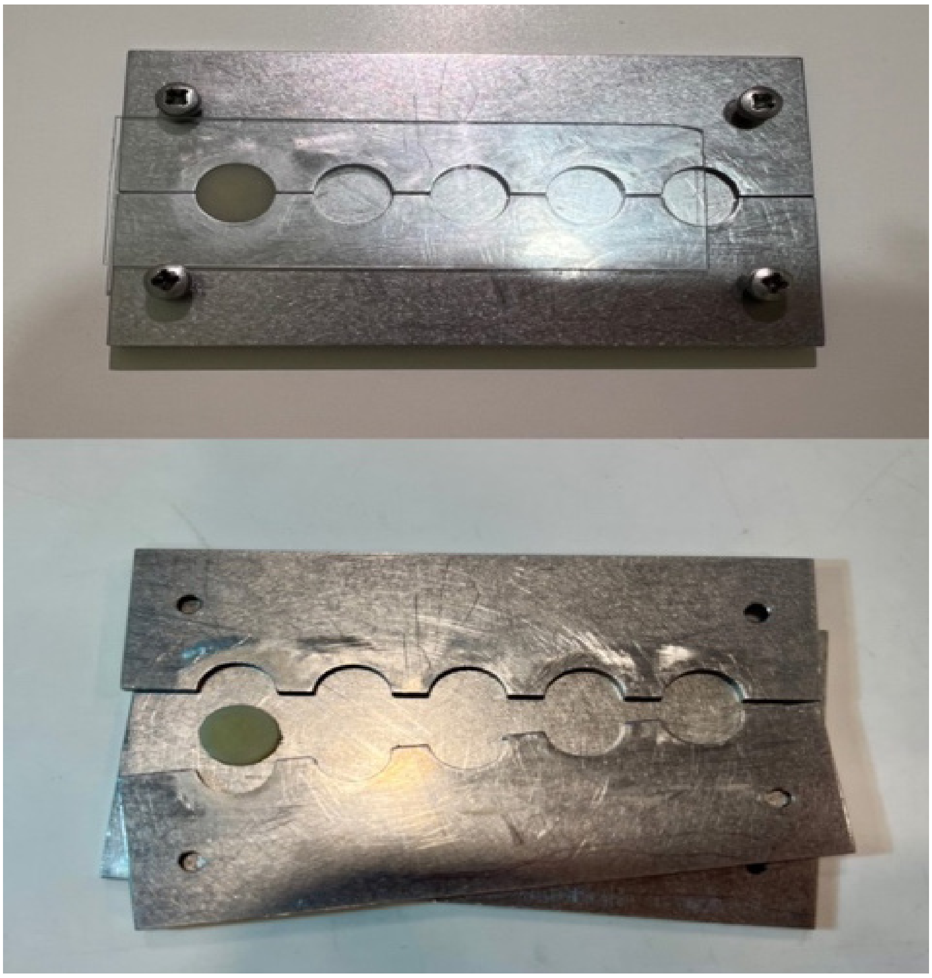


FIGURE 4. Sample preparation using customised stainless-steel mould with 10 mm × 2 mm size holes

FIGURE 5. Plastic container with one specimen in each space

after polishing using the 3D Optical Surface Texture Analyzer (ALICONA, InfiniteFocus Real3D, Belgium). On each sample, measurements were taken five times at a magnification of 100x. From every location, at least five readings were obtained. Subsequently, five values were obtained for each sample by taking an average, which was then averaged again to reduce the result to one value of Ra (in µm, accurate to three decimal places) for each sample. The surface roughness reading was taken at baseline (before immersion) and 28 days after immersion.

FLEXURAL STRENGTH EVALUATION

Specimen preparation

The specimens were prepared according to the size of (25 ± 2) mm × (2 ± 0.1) mm × (2 ± 0.1) mm from ISO 4049 using a customized stainless-steel mould. Ten specimens each were prepared for all four different resin composite which are Omnichroma, Filtek Universal Restorative, Palfique LX5 and Beautifil II resin composite (Figure 6).

The specimens' top surface was first covered with a Mylar strip, then a glass slide with a thickness of 1 mm. The specimens were light-cured from the top surface for 40 s using Woodpecker LED.B curing lamp (Guilin Woodpecker Medical Instrument Co, Guilin, China) after the glass slide was taken out. The specimens were taken out of the mould, and the bottom surfaces were light-cured.

Flexural Strength Testing

Three point bending test was performed using the universal testing machine (UTM) (Shimadzu Corporation, Kyoto, Japan). Twenty-four hours after the start of curing the specimen, the specimens were applied with a load cell of 5KN and crosshead speed of 0.5 mm/min. The flexural strength will be calculated in megapascals, from the following equation:

$$\text{Flexural strength} = 3Fl/2bh^2$$

where F is the maximum load applied to the specimen in Newton; l is the distance, measured in mL with an accuracy to ± 0,01 mm; b is the width, in mL, of the specimen measured immediately prior to testing; h is the height, in mL, of the specimen measured immediately prior to testing.

STATISTICAL ANALYSIS

Data analysis was carried out using SPSS software (Version 26.0. Armonk, NY: IBM Corp). The selection of statistical tests was based on the distribution of the data. Normality was assessed using the Shapiro-Wilk test. As the data were not normally distributed, non-parametric tests were employed. Specifically, the Kruskal-Wallis test was used for group comparisons, followed by Dunn's post-hoc test for pairwise comparisons. A significance level of p=0.05 was used for all statistical tests.

RESULTS AND DISCUSSION

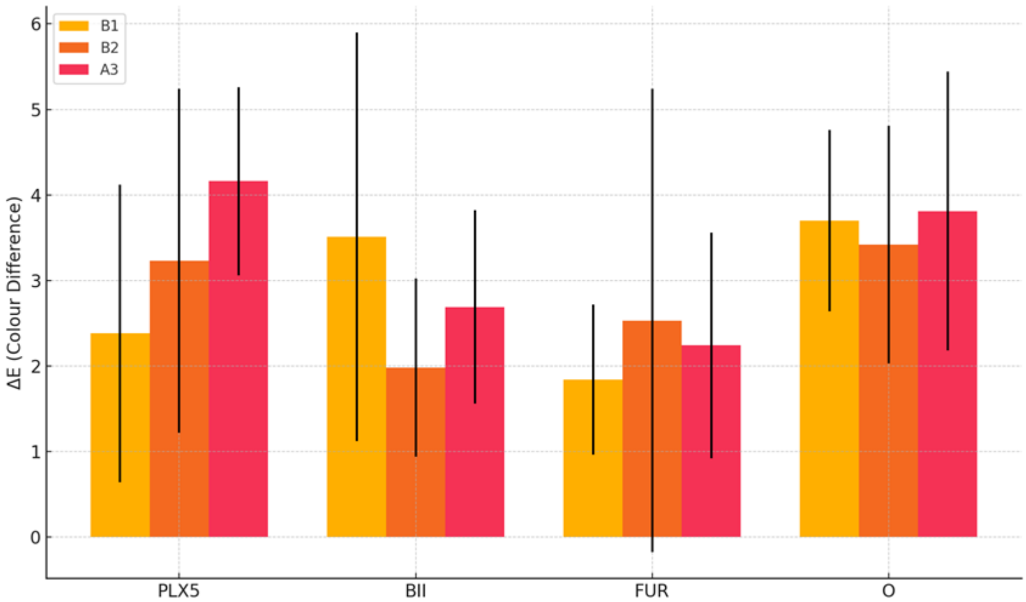
COLOUR MATCHING

The median and interquartile range of colour difference ΔEvalues of each resin composite was shown in Figure 7. The present study showed that A3 shade of Palfique LX5 stands out for having the most noticeable difference in colour between the acrylic tooth surface and the restoration with median colour difference of 4.16. This implies that the restoration may not blend as seamlessly with the natural tooth colour in this shade. In contrast, the B1 shade of Filtek Universal Restorative displays the smallest median colour difference and interquartile range which is 1.84 (0.88). This suggests that restorations in this shade achieve a closer match to the natural tooth colour, resulting in a more aesthetically pleasing outcome. From the present study, Omnichroma has a median value of 3.70 (B1), 3.42 (B2) and 3.81 (A3), respectively. The values were considered high as it is the second highest value of colour difference noted. The CIEDE 2000 colour parameter establishes that a perceptible difference in colour difference, when measured with a spectroradiometer on monochromatic VITA ceramic specimens within a predetermined tooth colour range, occurs at a threshold of 0.8, while an acceptable difference is indicated at 1.8 (Paravina et al. 2007). The results from the present photographic analysis showed that Omnichroma exceeding the acceptable threshold of 1.8 which mean that Omnichroma is above the level of acceptance.

As mentioned in Table 2, for shade B1, there is a significant difference between Filtek Universal Restorative and Omnichroma ($p<0.05$). This indicates that these two materials produce noticeably different colour outcomes when used for restorations in shade B1. Similarly, for shade A3, significant differences were found between Filtek Universal Restorative and Palfique LX5 ($p<0.05$). Therefore, the hypothesis was rejected, there is a statistical difference between the colour matching of single-shade resin composite with multi-shade system. Filtek Universal Restorative showed significantly better colour matching for B1 and A3 shade ($p<0.05$). Another study also showed that Filtek Universal Restorative showed significantly better colour matching in comparison to Omnichroma specimens for shades B1, B2, and A3 ($p < 0.01$) (AlHamdan et al. 2021). However, the result was contradicted by another study, which confirmed excellent colour matching ability for the structurally coloured resin composite Omichroma compared to Estelite Σ Quick Tokuyama and Filtek Universal Restrative, particularly for a cavity depth of 3.0 mm (Saegusa et al. 2021).

Filtek Universal nanocomposite, 3M ESPE has been frequently studied regarding colour matching and stability, therefore, it was chosen as one of the control group in the present study (AlHamdan et al. 2021; El-Rashidy et al. 2022; Kim & Park 2018). Resin composite are made of three components: An organic matrix; filler or disperse phase; and the coupling agent to bond the filler to the

FIGURE 6. Customized stainless-steel mould for specimens preparation for flexural strength testing



FUR, Filtek Universal Restorative; O, Omnichroma; PLX5, Palfique LX5; BII, Beutifill II

FIGURE 7. The colour difference of Omnichroma, Filtek Universal Restorative, Palfique LX5 and Beautifil II restoration with acrylic tooth

TABLE 2. The p-value of each resin composite for shade B1, B2 and A3

Shade of composite	N	p-value	p-value post hoc test
B1	40	0.005*	FUR-O p=0.006*
B2	40	0.014	
A3	40	0.002*	FUR-PLX5 p=0.001*

FUR, Filtek Universal Restorative; O, Omnichroma; PLX5, Palfique LX5
*Difference statistically significant between groups (p<0.05)

organic matrix. The optical properties of the restorations can be influenced by each of these components (Akgül & Gündoğdu 2022). The improved colour adjustment observed in Filtek Universal Restorative may be attributed to its organic matrix composition. Higher molecular weight monomers such as Bis-GMA are present, leading to an increased polymer crosslinking density (El-Rashidy et al. 2022).

Monochrome composite Omnichroma containing 260 nm spherical filler was introduced to the market. The Omnichroma has the ability to adapt to various tooth colours by creating a structural colour phenomenon and a wide reflection spectrum, resulting in a chameleon effect (Kobayashi et al. 2021). This allows clinicians the flexibility to use a single material that can match the colour of numerous teeth (Pereira Sanchez, Powers & Paravina 2019). A previous study of photographic analysis also showed that the Omnichroma has the highest colour difference values when compared to 3 other multi-shade composite, far above the level of acceptance of 1.8 (de Abreu et al. 2021).

COLOUR STABILITY

The colour stability results were shown in Table 3.

The colour stability levels of each composites were measured after soaking in distilled water and coffee for 28 days. More colour changes were observed in coffee rather than distilled water. Coffee is particularly effective in causing colour changes in composite resins because of its yellow colorant pigment, which exhibits a strong affinity with polymers (Nasim et al. 2010). Therefore, coffee was used in many studies for colour stability as well as our study.

Based on the result, Omnichroma has the highest median colour difference after immersion in distilled water for 28 days. However, the lowest colour difference was observed in Filtek Universal Restorative. The median colour difference between the lowest and highest values ranges from 1.42 to 2.93. There is no statistically difference between the colour stability of single-shade resin composite with multi-shade system after immersion in distilled water for 28 days (p>0.05). Distilled water was chosen as the control medium because previous studies have demonstrated that it does not cause any perceptible colour change in composite restorative materials (Ayad 2007).

The current study showed that after immersion in coffee for 28 days, Omnichroma exhibited the highest colour difference followed by Beautifil II, Palfique LX5 and lastly Filtek Universal Restorative. The colour changes after immersion in the various staining solutions cannot be attributed to pH-related surface changes alone (Tian et al. 2012). Coffee which exhibited only mild acidity with a pH of 6.28 resulted in the most significant discoloration.

The discoloration of restorative materials is influenced by multiple factors. Titratable acidity, the degree of resin polymerization, and the absorption or penetration of food colorants are among the factors that may contribute to the extent of staining observed. Besides that, toothpaste abrasiveness and brushing duration can contribute to increased colour changes (de Moraes Rego Roselino et al. 2015). The higher the abrasiveness of the toothpaste, the more it increases the surface roughness of resin composites, which in turn impacts the aesthetics of the restoration. The study concluded that the higher the toothpaste abrasiveness and the longer the brushing duration, the more significant the colour change in resin composite.

There is a statistical significance between the colour stability of single-shade resin composite with multi-shade system after immersion in coffee for 28 days with p-value<0.05. The post-hoc tests showed that there is a statistical significant between Filtek Universal Restorative and Omnichroma after immersion in coffee for 28 days (p-value<0.05). Filtek Universal Restorative was found to have the lowest colour difference value when analysed in terms of colour stability in the present study. The reason could be due to increased presence of Bis-GMA in the organic matrix of Filtek Universal Restorative. It is known that the resin matrix of dental composites has the ability to absorb water, with a lower filler ratio typically resulting in higher water sorption (Gonulol, Ozer & Sen Tunc 2015). Bis-GMA is a highly hydrophobic resin monomer that has been observed to enhance mechanical properties and reduce water solubility in aqueous environments. Research findings have indicated that incorporating Bis-GMA

TABLE 3. The median colour difference ΔE values and interquartile range of each composite after immersion in distilled water and coffee for 28 days

	PLX5 Median (IqR)	BII Median (IqR)	FUR Median (IqR)	O Median (IqR)	p-value	p-value post hoc test
Control (Distilled water)	2.30 (1.10)	2.65 (0.58)	1.41 (2.32)	2.93 (1.59)	0.354	
Coffee	9.04 (5.57)	11.30 (2.32)	8.01 (21.35)	11.50 (3.75)	0.009*	FUR-O p=0.010*

FUR, Filtek Universal Restorative; O, Omnichroma; PLX5, Palfique LX5; BII, Beutifill II

*Difference statistically significant between groups (p<0.05) monomer into resin formulations leads to the development of a more resilient and water-resistant composite material (Kazak et al. 2020). A similar results was found in the another study that Filtek Universal Restorative have better colour stability than Omnichroma (AlHamdan et al. 2021). Study has showed that resin composites containing Bis-GMA monomer exhibit less colour difference, attributed to the formation of a rigid network, compared to those containing triethylene glycol dimethacrylate (TEGDMA). Consistent with previous research, Omnichroma containing TEGDMA displayed the highest ΔE values, although this difference was not statistically significant in this study (de Abreu et al. 2021).

SURFACE ROUGHNESS

The surface roughness of a resin composite can be affected by several factors related to the fillers incorporated into the material such as filler size, filler content, filler distribution and lastly filler composition (Lim et al. 2008). Overall, optimizing filler size, content, distribution, and composition is essential for controlling and minimizing surface roughness in resin composite materials, which is critical for achieving aesthetic and functional success in dental restorations. In the present study, four different resin composites were selected, each with unique filler compositions. The Beautifil II composed of microfilled filler particles. Filtek Universal Restorative contains a hybrid filler system, consisting of a combination of micro and nanofillers. Omnichroma contains uniform-sized supra-nano spherical fillers with a diameter of 260 nm. Lastly, Palfique LX5 contains supra-nano spherical fillers with an average size of 200 nm.

Based on the pre-soaking surface roughness results shown on Figure 8, Omnichroma has the highest surface roughness (Ra) which is 0.28-0.29 μm. In numerous studies, the typical critical threshold for surface roughness has been identified as 0.2 μm (Bollenl, Lambrechts & Quirynen 1997; Jones, Billington & Pearson 2004; Park et al. 2019). However, there is no universally accepted threshold for assessing surface roughness. A clinical study showed that patients were only able to detect a mean surface roughness of above 0.3 μm (Jones, Billington & Pearson 2004). Based on the findings of the current study, the surface roughness values of all the resin composites were below 0.3 μm before undergoing soaking.

According to the present study, there is no statistical significance between the surface roughness of single-shade resin composite with multi-shade system before immersion (p-value>0.05). This implies that the surface roughness value of each resin composites after polishing with Sof-LexTM (3M ESPE, St. Paul, MN, USA) is not influenced by filler size or distribution according to the present study. Several studies have concluded that there is no significant difference between surface roughness vales of the different filler size resin composite (Aytac et al. 2016). However, certain studies have suggested that composites containing nanofillers may exhibit different characteristics due to the narrow range of filler particle sizes, resulting in a more effective polishing effect (Mitra, Wu & Holmes 2003).

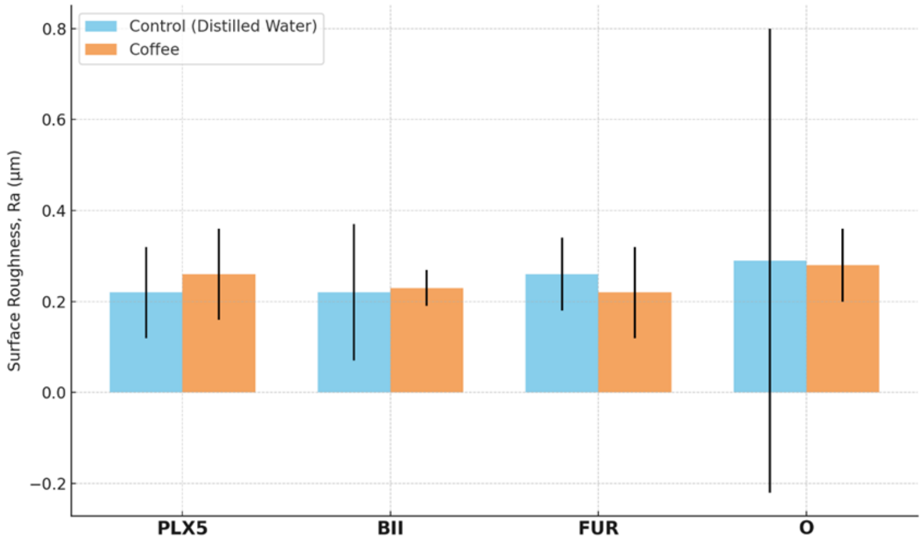
After soaking in water and coffee for 28 days, Omnichroma continued to exhibit the highest surface roughness compared to other multi-shade system which shown in Figure 9. However, Beautifil II showed the lowest surface roughness after immersion in water and coffee for 28 days. There is no statistical significance between the surface roughness of single-shade resin composite with multi-shade system after immersion in water and coffee for 28 days, respectively. This suggested that the study found no significant effect of composite materials with different filler sizes on surface roughness.

FLEXURAL STRENGTH

There are limited data available regarding the mechanical properties of Omnichroma. According to Figure 10, the lowest flexural strength values were observed in Filtek Universal Restorative followed by Beautifil II, then, Palfique LX5 and lastly Omnichroma showed the highest flexural strength values. The flexural strength of resin composite as a restoration materials should be equal to or greater than 80MPa according to the ISO 4049. Each specimens of the present study demonstrated a flexural strength exceeding 80MPa. Flexural strength is an important indicator used to assess the ability of a material to withstand chewing loads especially in the posterior molar region (Beltrami et al. 2018). The average maximum bite force ranges from 300 to 600 N in molar region of healthy adults (Hagberg 1987).

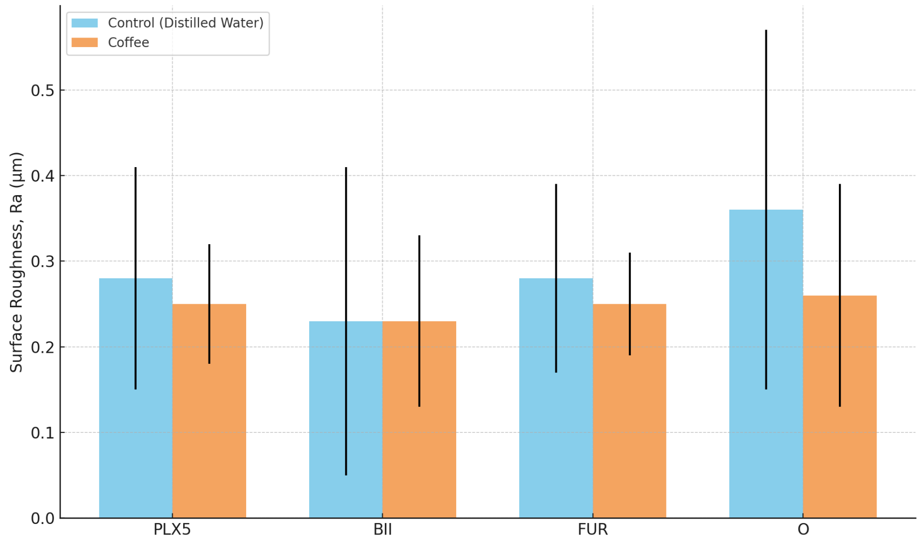
Previous studies have suggested that increasing the volume percentage of fillers in dental materials can lead to improvements in flexural strength. Specifically, these improvements have been noted to occur up to a volume percentage of 80. This indicates that a higher filler content can contribute to enhancing the material's ability to withstand bending forces, which is crucial for its performance in dental applications (Graf & Ilie 2022). According to the results of the present study, Beautifil II then Palfique LX5 and lastly Omnichroma have higher volume percentage of filler compared to Filtek Universal Restorative.

The Kruskal-Wallis test showed significant differences between the flexural strength of the resin composites ($p<0.05$) as suggested in Table 4. Among the groups, Omnichroma showed statistically significantly highest mean rank than other multi-shade resin composite. Based on Table 5, the post-hoc tests showed that there is a statistically significant between Filtek Universal Restorative and Omnichroma in terms of the flexural strength. This indicates that these two materials exhibit distinct mechanical properties when subjected to flexural strength testing. However, the flexural strength was measured at 24 h after curing, no long-term



FUR, Filtek Universal Restorative; O, Omnichroma; PLX5, Palfique LX5; BII, Beutifill II

FIGURE 8. The median and interquartile range of surface roughness (R_a) of each resin composite before soaking in distilled water and coffee



FUR, Filtek Universal Restorative; O, Omnichroma; PLX5, Palfique LX5; BII, Beutifill II

FIGURE 9. The median and interquartile range of surface roughness (R_a) of each resin composite after soaking in distilled water and coffee

TABLE 4. The mean rank and p-value for the four resin composites

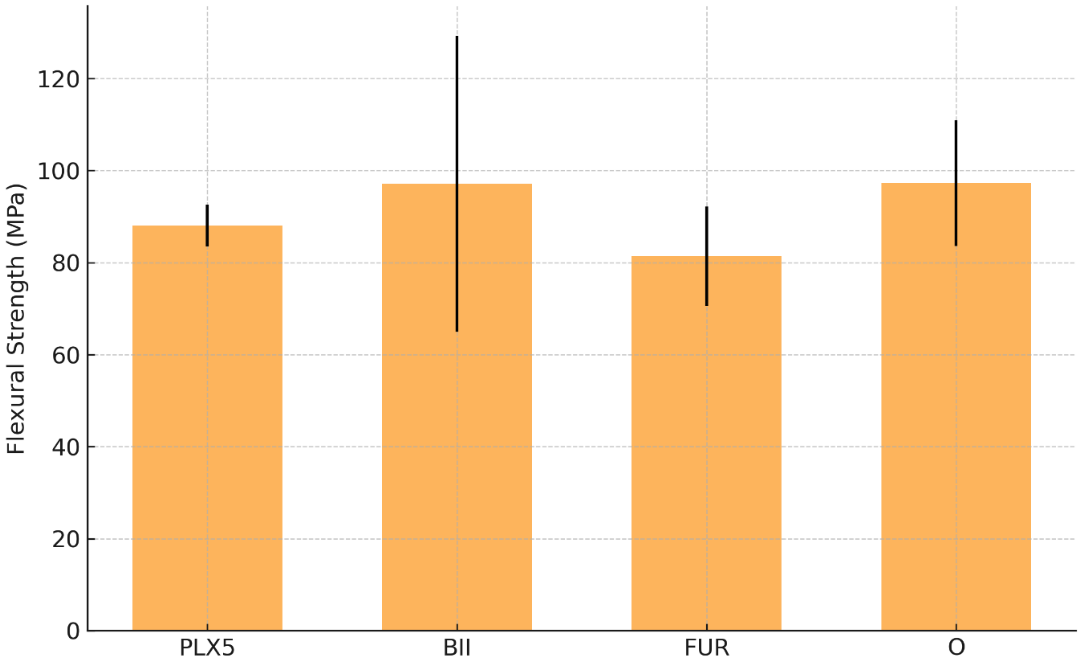
Composite groups	Mean rank	p-value
PLX5	18.10	0.008*
BII	23.20	
FUR	11.70	
O	29.00	

FUR, Filtek Universal Restorative; O, Omnichroma; PLX5, Palfique LX5; BII, Beutifill II
*Difference statistically significant between groups (p<0.05)

TABLE 5. The post-hoc tests for each resin composites on the flexural strength

Composite groups	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
FUR-PLX5	6.400	5.228	1.224	.221	1.000
FUR-BII	11.500	5.228	2.200	.028	.167
FUR -O	-17.300	5.228	-3.309	.001	.006*
PLX5-BII	-5.100	5.228	-.975	.329	1.000
PLX5-O	-10.900	5.228	-2.085	.037	.222
BII-O	-5.800	5.228	-1.109	.267	1.000

FUR, Filtek Universal Restorative; O, Omnichroma; PLX5, Palfique LX5; BII, Beutifill II
*Difference statistically significant between groups (p<0.05)



FUR, Filtek Universal Restorative; O, Omnichroma; PLX5, Palfique LX5; BII, Beutifill II

FIGURE 10. The median and interquartile range of flexural strength of each resin composite

assessment was performed. The mean flexural strength obtained in the current study is 97.30 MPa which is higher than the results from another study that reported 86.4 MPa for Omnichroma (Schweppe et al. 2020).

The limitations of this study include the use of acrylic teeth instead of natural teeth for colour matching, as natural teeth vary in shade, translucency, and surface characteristics. As we know too, the shades of different brand of acrylic teeth and natural teeth often differ in several aspects. For colour stability evaluation, only coffee and distilled water were used for immersion, additional solutions like tea and cola should have been included. Additionally, only one polishing system (Sof-Lex™ discs) was used for surface roughness evaluation. Besides that, as an *in vitro* study, the controlled lab conditions may not fully reflect real oral environments. Lastly, water contact angle (WCA) measurements can be incorporated into the study, as they provide valuable insights into the hydrophobicity of resin composites, which in turn influences their colour stability. However, direct studies linking WCA to colour stability in resin composites are limited.

The study suggests that while single-shade resin composites offer practical advantages such as simplified shade selection and acceptable flexural strength, they exhibit lower colour matching and greater susceptibility to staining after coffee exposure compared to multi-shade systems (Lee & Kim 2021; Smith, Doe & Johnson 2020). Both systems demonstrated similar surface roughness, suggesting comparable potential for plaque retention (Park et al. 2019). Clinically, single-shade composites may be appropriate for small or posterior restorations where aesthetics are less critical, whereas multi-shade systems are preferable in highly visible, aesthetic zones (Martínez et al. 2021). Patients should be informed about the potential for staining, and further clinical trials are recommended to confirm long-term outcomes (Bisharah et al. 2024).

CONCLUSIONS

Within the limitations of the present study, the following conclusions can be drawn: 1). The single-shade resin composite used in anterior restorations demonstrated varying levels of colour matching, with the multi-shade resin composite system achieving superior colour match, 2). After immersion in coffee for 28 days, the single-shade resin composite exhibited greater colour change compared to the multi-shade system, 3). Surface roughness values were similar between single-shade and multi-shade resin composites, both before and after immersion in distilled water or coffee, and 4). The flexural strength of the single-shade resin composite was found to be within acceptable limits; however, further clinical studies are recommended to validate these findings. While Omnichroma resin composite offers promising aesthetic blending properties, it cannot yet fully replace other composite restorative materials. Additional strengthening and formulation improvements are needed to enhance its clinical performance, while maintaining its unique ability to match the surrounding tooth structure.

ACKNOWLEDGEMENTS

We gratefully acknowledge the staff of the Biomaterial Research Laboratory, Faculty of Dentistry, Universiti Malaya, for their invaluable assistance during our laboratory sessions.

REFERENCES

Akgül, S. & Gündoğdu, C. 2022. Color change evaluation of three universal resin composites after storage in water: An *in vitro* study. *Journal of Advanced Oral Research* 13(2): 176-182. DOI: 10.1177/22753035221106259

AlHamdan, E.M., Bashiri, A., Alnashmi, F., Al-Saleh, S., Al-Shahrani, K., Al-Shahrani, S. & Vohra, F. 2021. Evaluation of smart chromatic technology for a single-shade dental polymer resin: An *in vitro* study. *Applied Sciences* 11(21): 10108. DOI: 10.3390/app112110108

Ayad, N.M. 2007. Susceptibility of restorative materials to staining by common beverages: An *in vitro* study. *European Journal of Esthetic Dentistry* 2(2): 144-150. DOI: 10.1111/j.1600-0401.2007.00153.x

Aytac, F., Karaarslan, E.S., Agaccioglu, M., Tastan, E., Buldur, M. & Kuyucu, E. 2016. Effects of novel finishing and polishing systems on surface roughness and morphology of nanocomposites. *Journal of Esthetic and Restorative Dentistry* 28(4): 247-261. https://doi.org/10.1111/jerd.12215

Beltrami, R., Ceci, M., De Pani, G., Vialba, L., Federico, R., Poggio, C. & Colombo, M. 2018. Effect of different surface finishing/polishing procedures on color stability of esthetic restorative materials: A spectrophotometric evaluation. *European Journal of Dentistry* 12(1): 49-56. https://doi.org/10.4103/ejd.ejd_185_17

Bisharah, W.F., Zahran, A.S., Rajeh, M.T., Abdel Aleem, N.A. 2024. *In vitro comparison of color matching: Universal shade composite resin vs multi-shade conventional composite. Journal of Contemporary Dental Practice* 25(11): 1039-1044. doi:10.5005/jp-journals-10024-3780

Bollenl, C.M., Lambrechts, P. & Quirynen, M. 1997. Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: A review of the literature. *Dental Materials* 13(4): 258-269. DOI: 10.1016/S0109-5641(97)00029-4

Chu, S.J., Trushkowsky, R.D. & Paravina, R.D. 2010. Dental color matching instruments and systems: Review of clinical and research aspects. *Journal of Dentistry* 38(Suppl 2): e2-e16. DOI: 10.1016/j.jdent.2010.07.001

de Abreu, J.L.B., Sampaio, C.S., Jalkh, B., Byron, E. & & Hirata, R. 2021. Analysis of the color matching of universal resin composites in anterior restorations. *Journal of Esthetic and Restorative Dentistry* 33(2): 269-276. https://doi.org/10.1111/jerd.12659

de Moraes Rego Roselino, L., Chinelatti, M.A., Alandia-Román, C.C. & de Carvalho PanzeriPires-de-Souza, F. 2015. Effect of brushing time and dentifrice abrasiveness on color change and surface roughness of resin composites. *Brazilian Dental Journal* 26(5): 507-513. https://doi.org/10.1590/0103-6440201300399

El-Rashidy, A.A., Abdelraouf, R.M. & Habib, N.A. 2022. Effect of two artificial aging protocols on color and gloss of single-shade versus multi-shade resin composites. *BMC Oral Health* 22(1): 321. https://doi.org/10.1186/s12903-022-02351-7

El-Refai, D.A. 2022. *Can Omnichroma revoke other restorative composites? Mechanical and physical assessment of Omnichroma dental resin restorative composite: An in vitro study. Egyptian Dental Journal* 68(4): 3701-3716. doi: 10.21608/edj.2022.157174.2222

Graf, N. & Ilie, N. 2022. *Long-term mechanical stability and light transmission characteristics of one shade resin-based composites. Journal of Dentistry* 116: 103915. https://doi.org/10.1016/j.jdent.2021.103915

Gonulol, N., Ozer, S. & Sen Tunc, E. 2015. Water sorption, solubility, and color stability of giomer restoratives. *Journal of Esthetic and Restorative Dentistry* 27(5): 300-306. https://doi.org/10.1111/jerd.12119

Hagberg, C. 1987. *Assessments of bite force: A review*. *Journal of Craniomandibular Disorders* 1(3): 162-169.

Hassan, A.M., El-Damanhoury, H.M. & El-Badrawy, W.A. 2022. *Effect of two artificial aging protocols on color and gloss of single-shade versus multi-shade resin composites. BMC Oral Health* 22(1): 321. DOI: 10.1186/s12903-022-02351-7

Jones, C.S., Billington, R.W. & Pearson, G.J. 2004. The *in vivo* perception of roughness of restorations. *British Dental Journal* 196(1): 42-45. https://doi.org/10.1038/sj.bdj.4810881

Kazak, M., Tiryaki, M., Basaran, E.T. & Gokce, Y.B. 2020. Evaluating the effects of different beverages with daily consumption habits on the wear of restorative materials. *Odontology* 108(4): 636-645. https://doi.org/10.1007/s10266-020-00498-9

Kim, D. & Park, S.H. 2018. Color and translucency of resin-based composites: Comparison of a-shade specimens within various product lines. *Operative Dentistry 43*(6): 642-655.

Kobayashi, S., Nakajima, M., Furusawa, K., Tichy, A., Hosaka, K. & Tagami, J. 2021. Color adjustment potential of single-shade resin composite to various-shade human teeth: Effect of structural color phenomenon. *Dental Materials Journal* 40(4): 1033-1040. https://doi.org/10.4012/dmj.2020-364

Kundie, F., Azhari, C.H., Muchtar, A. & Ahmad, Z.A. 2018. Effects of filler size on the mechanical properties of polymer-filled dental composites: A review of recent developments. *Journal of Physical Science* 29(1): 141-165. DOI: 10.21315/jps2018.29.1.11

Lee, Y. & Kim, J. 2021. Evaluation of color-matching ability of a structural colored resin composite. *Operative Dentistry* 46(3): 306-315. https://doi.org/10.2341/20-002-L

Lim, Y.K., Lee, Y.K., Lim, B.S., Rhee, S.H. & Yang, H.C. 2008. Influence of filler distribution on the color parameters of experimental resin composites. *Dental Materials* 24(1): 67-73. https://doi.org/10.1016/j.dental.2007.02.007

Mahmoudi Meimand, N., Tsoi, J.K.H., Burrow, M.F., He, J. & Cho, K. 2024. A comparative study on the mechanical and antibacterial properties of BPA-free dental resin composites. *Dental Materials* 40(8): 31-39. https://doi.org/10.1016/j.dental.2024.06.024

Martínez, A., Yamaguchi, S., Lee, C., Karaer, O. & Imazato, S. 2021. Color adjustment potential of single-shade resin composite to various-shade human teeth: Effect of structural color phenomenon. *Dental Materials Journal* 40(4): 1030-1037. https://doi.org/10.4012/dmj.2020-364

Menon, A., Ganapathy, D.M. & Mallikarjuna, A.V. 2019. Factors that influence the colour stability of composite resins. *Drug Invention Today* 11(3): 465-468. DOI: 10.5958/0975-4385.2019.00092.1

Mitra, S.B., Wu, D. & Holmes, B.N. 2003. An application of nanotechnology in advanced dental materials. *The Journal of the American Dental Association* 134(10): 1382-1390. https://doi.org/10.14219/jada.archive.2003.0054

Mizutani, K., Takamizawa, T., Ishii, R., Shibasaki, S., Kurokawa, H., Suzuki, M., Tsujimoto, A. & Miyazaki, M. 2021. *Flexural properties and polished surface characteristics of a structural colored resin composite*. *Operative Dentistry* 46(3): E117-E131. doi: 10.2341/20-154-L

Moraes, R.R., Cenci, M.S., Moura, J.R., Demarco, F.F., Loomans, B. & Opdam, N. 2022. Clinical performance of resin composite restorations. *Current Oral Health Reports* 9(2): 22-31.DOI: 10.1007/s40496-022-00509-0

Nasim, I., Neelakantan, P., Sujeer, R. & Subbarao, C.V. 2010. Color stability of microfilled, microhybrid and nanocomposite resins - An *in vitro* study. *Journal of Dentistry* 38(Suppl 2): e137-e142. https://doi.org/10.1016/j.jdent.2010.05.020

Oivanen, M., Keulemans, F., Garoushi, S., Vallittu, P.K. & Lassila, L. 2021. The effect of refractive index of fillers and polymer matrix on translucency and color matching of dental resin composite. *Biomaterial Investigations in Dentistry* 8(1): 48-53. DOI: 10.1080/23273798.2021.1906879

Omnichroma. 2019. Simplifying the restorative process. *Compendium of Continuing Education in Dentistry* 40(8): 1-6. DOI: 10.12968/denu.2019.40.8.1

Paravina, R.D., Majkic, G., Imai, F.H. & Powers, J.M. 2007. Optimization of tooth color and shade guide design. *Journal of Prosthodontics* 16(4): 269-276. https://doi.org/10.1111/j.1532-849X.2007.00189.x

Park, J.W., An, J.S., Lim, W.H., Lim, B.S. & Ahn, S.J. 2019. Microbial changes in biofilms on composite resins with different surface roughness: An *in vitro* study with a multispecies biofilm model. *The Journal of Prosthetic Dentistry* 122(5): 493.e1-493.e8. https://doi.org/10.1016/j.prosdent.2019.08.009

Pereira Sanchez, N., Powers, J.M. & Paravina, R.D. 2019. Instrumental and visual evaluation of the color adjustment potential of resin composites. *Journal of Esthetic and Restorative Dentistry* 31(5): 465-470. DOI: 10.1111/jerd.12534

Quirynen, M. & Bollen, C. 1995. The influence of surface roughness and surface-free energy on supra-and subgingival plaque formation in man: A review of the literature. *Journal of Clinical Periodontology* 22(1): 1-14. DOI: 10.1111/j.1600-051X.1995.tb00107.x

Ren, Z., Chen, H., Wang, R. & Zhu, M. 2024. Comparative assessments of dental resin composites: A focus on dense microhybrid materials. *ACS Biomaterials Science & Engineering* 10(6): 3718-3726. https://doi.org/10.1021/acsbiomaterials.4c00403

Saegusa, M., Kurokawa, H., Takahashi, N., Takamizawa, T., Ishii, R., Shiratsuchi, K. & Miyazaki, M. 2021. Evaluation of color-matching ability of a structural colored resin composite. *Operative Dentistry* 46(3): 306-315.

Schweppe, J., Utterodt, A., Meier, C., Eck, M. & Reischl, K. 2020. *Comparison of strength and esthetics of novel single shade composites. Proceedings of the IADR/AADR/CADR General Session* (Washington, DC, USA).

Sharma, N. & Samant, P.S. 2021. OMNICHROMA: The see-it-to-believe-it technology. *EAS Journal of Dental and Oral Medicine* 3(3): 100-104.

Smith, J., Doe, A. & Johnson, L. 2020. Evaluation of single-shade composite resin color matching on extracted human teeth. *Journal of Esthetic and Restorative Dentistry* 32(5): 456-462. https://doi.org/10.1111/jerd.12671

Terry, D.A. & Leinfelder, K.F. 2004. An integration of composite resin with natural tooth structure: The Class IV restoration. *Practical Procedures & Aesthetic Dentistry* 16(3): 235-246.

Tian, F., Tan, H., Yao, X. & Li, L. 2012. Effect of staining solutions on the color of pre-reacted glass-ionomer containing composites. *Dental Materials Journal 31*(3): 384-388.

Yannikakis, S.A., Zissis, A.J., Polyzois, G.L. & Caroni, C. 1998. Color stability of provisional resin restorative materials. *Journal of Prosthetic Dentistry* 80(5): 533-539.

*Corresponding author; email: hadijah@mahsa.edu.my